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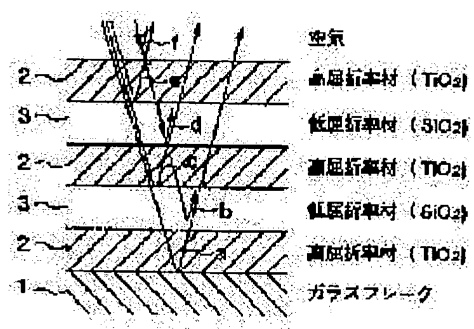
(54) OPTICAL INTERFERENCE MATERIAL AND COATING MATERIAL CONTAINING THE SAME

(57)Abstract:

PURPOSE: To produce an optical interference material capable of brightly coloring with the intensity worthy of a coloring material individually without using a pigment or reflecting heat ray and a coating material containing the same.

CONSTITUTION: The optical interference material having ≥90% total reflectance is formed by alternately laminating a high reflectance material layer 2 and a low reflectance material layer 3 respectively by the thickness odd numbered times as large as about 1/(4n) wavelength ((n): reflectance of the reflectance material layer) of a set interference light and the coating material is obtained by incorporating the optical interference material in a base coating material resin.



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CLAIMS

[Claim(s)]

[Claim 1] Optical interference material characterized by carrying out the laminating of a high refractive-index mater layer and the low refractive-index material layer respectively by turns at a base material by odd times as much optica thickness as the abbreviation quarter-wave length of a setting interference light.

[Claim 2] For the refractive index of the refractive-index material layer by which the laminating of that refractive ind is carried out to right above [of this] in optical interference material according to claim 1, the above-mentioned base material is optical interference material characterized by height being opposite.

[Claim 3] Optical interference material characterized by a total reflection factor being 90% or more in optical interference material given in claims 1 and 2.

[Claim 4] The coating characterized by mixing optical interference material according to claim 1 into base coating resin.

[Claim 5] The coating characterized by mixing optical interference material according to claim 2 into base coating resin.

[Claim 6] The coating characterized by mixing optical interference material according to claim 3 into base coating resin.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the optical interference material slack interference flake of this inventio
[Drawing 2] It is the expanded sectional view of the A section of drawing 1 .
[Drawing 3] It is the schematic diagram showing the manufacture approach of the optical interference material of thi invention.
[Drawing 4] It is drawing having shown the bending fracture machine used by the manufacture approach of drawing

[Drawing 5] It is the sectional view showing the fracture wafer obtained with the fracture machine of drawing 4 .
[Drawing 6] It is drawing which illustrated the paint structure using the coating of this invention.
[Drawing 7] It is the schematic diagram showing the manufacture approach of other optical interference material of t invention.
[Drawing 8] It is drawing showing the relation between the reflection factor of other optical interference material of this invention, and the depth of shade by viewing.
[Drawing 9] It is the conceptual diagram showing an operation of the optical interference material of this invention.
[Drawing 10] It is the sectional view showing the example of a configuration of the optical interference material of t invention.
[Drawing 11] It is what showed the optical interference material as a heat ray reflector of this invention, and is drawi in which (a) shows the interference flake and (b) shows the enlarged section of the A section.
[Drawing 12] It is drawing with which explanation of a principle operation of this invention is presented.
[Drawing 13] It is the sectional view having shown the conventional interference mica.
[Drawing 14] It is the expanded sectional view of the B section of drawing 13 .
[Description of Notations]
1 Base Material of Fine Thin Film Integrated Circuit
2 High Refractive-Index Material Layer
3 Low Refractive-Index Material Layer
10 Optical Interference Material Slack Interference Flake

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the coating containing the optical interference material and it which act as interference coloring material or a heat ray reflector.
[0002]
[Description of the Prior Art] Recently, according to a demand of diversification of the design nature of a paint appearance, the metallic coating which includes the piece of aluminum (aluminum flake) and the pigment with comparatively high transparency of a fine thin film integrated circuit into a base coating, and the pearl mica paint wh includes the interference mica flake which coated the titanium dioxide (TiO2), and a pigment with comparatively hig transparency in the mica (mica flake) of a fine thin film integrated circuit into a base coating have been used abundantly.
[0003] The interference mica flake included into a base coating in the latter pearl mica paint coats with the titanium-dioxide film 21 (refractive index n= 2.7) with a somewhat high refractive index the front face of the mica flake 20 (refractive-index n=1.5-2.0) which consists of the mica of a fine thin film integrated circuit by one fourth of the thickness (quadrant wavelength film) of the wavelength of the color of an aim, as shown in drawing 13 . As shown in drawing 14 , by interference with the reflected light 22 from the interface of a titanium oxide layer and a mica, and th reflected light 23 from the titanium oxide layer front face by which coating was carried out, only a certain wavelengt is made to emphasize, interference coloring is carried out, and it is observed as coloring material using interference o light.
[0004] About the mica base coating which blended the pigment currently used for current automobiles, JP,63-319087,A has indication, for example.
[0005] Moreover, the front face of a mica flake is made to cover a titanium dioxide to homogeneity, and JP,5-8342,A has the indication about the interference mica flake which re-covered the titanium dioxide on the front face, and obtained it on it again, and the sheet plastic which was made to distribute this in transparence resin and raised design nature, after returning this once and using some titanium dioxides as black low hypo---ic acid-ized titanium.
[0006] Since these interference mica flakes can make ********** Infinite Color of theory top infinity by adjusting t thickness of a black low hypo---ic acid-ized titanium and a black titanium dioxide, they attract attention as coloring material using interference of light.
[0007]
[Problem(s) to be Solved by the Invention] However, the conventional interference mica flake has a very thin color i itself [of the thing which can color various hues / coloring]. That is, since the titanium dioxide is the much more, a beam-of-light reflection factor becomes 43% or less, and it is hard to call that the color of appearance is thin and is coloring material.
[0008] Then, in order to compensate only with an interference mica flake single the fault that a color does not come out, the present condition is using it, mixing a pigment with others in fact. For this reason, it had also become light other than the color aimed at being mixed, and not looking skillfully.
[0009] The purpose of this invention is to offer the coating containing the optical interference material and it which t above-mentioned technical problem is solved, and coloring can be skillfully done in the strength which deserves call coloring material only alone, without using a pigment, or can reflect a heat ray.
[0010]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the optical interference material of this invention is the thing of a configuration of having carried out the laminating of a high refractive-index material layer and the low refractive-index material layer to the base material respectively by turns by odd times as much opti thickness (geometric thickness x refractive index) as the abbreviation quarter-wave length of a setting interference li (claim 1).

[0011] That refractive index makes the above-mentioned base material what has opposite height with the refractive index of the refractive-index material layer by which a laminating is carried out to right above [of this] (claim 2).
[0012] Moreover, in these optical interference material, a desirable total reflection factor considers as 90% or more o interference coloring material (claim 3).
[0013] On the other hand, the coating of this invention is the thing of a configuration of having mixed optical interference material according to claim 1, i.e., the thing which carried out the laminating of a high refractive-index material layer and the low refractive-index material layer respectively by turns at the base material by odd times as much optical thickness as the abbreviation quarter-wave length of a setting interference light, into base coating resin (claim 4).
[0014] Optical interference material according to claim 2 or optical interference material according to claim 3 can be mixed into base coating resin, and it can also consider as a coating (claims 5 and 6).
[0015]
[Function] As shown in drawing 12 , a high refractive-index material layer (refractive index n1) and a low refractive index material layer (refractive index n2) by turns When the laminating is carried out by dense, the non-dense, dense and the non-dense, although the phase of light does not change about the light a and c reflected when light goes to secret non-denses, about the light b reflected when going densely from a non-dense, the phase of light carries out hal wave length change. Then, if these phases are arranged, the light of a and b will interfere, for example. Here, it is a refractive index n2 for considering the phase shift of the light of a and b. When thickness of a low refractive-index material layer is set to x, about the optical distance of b, they are 2 x-n2. Since the phase is carrying out half-wave length change when Light b is reflected, although it becomes, it is -(2x+(one half) lambda) n2 in fact. It becomes. On the other hand, since, as for the optical part of a, the phase is not changing, the light of b is -(2x+(one half) lambda) n =mlambda. (m= 1, 2, 3 --)
It suits in a slight light and the slight strength of a at the time of **. When this is solved about x, it is x=(2m-1) lamb (four n2). (m= 1, 2, 3 --)
The low refractive-index material layer (refractive index n2) of light [a next door and] of b suits in slight Light a an slight strength at the time of one odd times the thickness of lambda/(4n2).
[0016] This invention applies such a principle.
[0017] A setting interference light is the light and claim 1 includes two gestalten, the case where optical interference material is obtained as interference coloring material, and when a setting interference light is a heat ray (infrared radiation) and it is obtained as a heat ray reflector.
[0018] It sets at claims 1, 2, and 3 to explain from the gestalt as interference coloring material. For example, the ligh which is reflected among ** incident light by the interface between a base material 1 and the high refractive-index layer 2 of the right above of it in the case of five layers shown in drawing 2 The light c reflected by interferential act with the light b reflected by the interface with the low refractive-index material layer 3 and the high refractive-index material layer 2, and the interface between ** quantity refractive-index material layer 2 and the low refractive-index material layer 3 Interferential action with the light f reflected by the interface between Light e and air which are reflected by interferential action with the light d reflected by the interface between the low refractive-index material layer 3 and the high refractive-index material layer 2 and the interface between ** quantity refractive-index material layer 2 and the low refractive-index material layer 3, and the high refractive-index material layer 2 arises.
[0019] namely, the conventional titanium dioxide -- although the color of appearance was very thin since the beam-o light reflection factor had become 43% or less when the much more -- the above-mentioned laminated structure -- a total beam-of-light reflection factor -- an easy configuration -- effective -- it can raise -- a result -- a deep interferenc light -- it can color . Moreover, since the thickness of a titanium dioxide is odd times the quarter-wave length, skillfu coloring with which any light other than the color aimed at is not mixed is obtained.
[0020] Since a reflection factor is especially 90% or more in claim 3, remarkable effectiveness is acquired.
[0021] The coating of claims 4, 5, and 6 makes the above coloring material mix. although it is transparent in itself [optical interference material] -- the laminating of refractive-index material -- the color of a certain wavelength -- enough -- a color -- since it is what can carry out interference coloring deeply, a desired coating can be obtained without a pigment.
[0022] The gestalt as a heat ray reflector is made into the heat ray reflector in which infrared radiation is reflected by the above-mentioned principle, and the heating value which the base of an automobile itself absorbs is decreased, it i suitable for the application of suppressing the temperature rise of an automobile, and it is constituted as a coating corresponding to above-mentioned claims 4-6 containing the heat ray reflector and it corresponding to the optical interference material of above-mentioned claims 1-3 therefore.
[0023]
[Example] Hereafter, one example of this invention is explained in full detail based on an accompanying drawing. Drawing 1 carries out the laminating of the high refractive-index material layer 2 and the low refractive-index mater

·layer 3 to the base material 1 of a fine thin film integrated circuit respectively by turns by the optical thickness (geometric thickness x refractive index) of the abbreviation quarter-wave length of setting interference coloring light and makes a reflection factor 90% or more so that drawing 2 which showed the cross section of the interference coloring material slack interference flake 10 of this invention, and expanded and showed the A section may show.
[0024] Here, the glass flake (refractive index n= 1.5) is used as a base material 1 of a fine thin film integrated circuit it is an ingredient used as the base, although this base material 1 is good, since it is desirable to actually make this smooth and to arrange a curve, the glass flake is being used for it anything here. Moreover, the silica SiO2 (refractiv index n= 1.5) is used as a low refractive-index material layer 3 which carries out a laminating a titanium dioxide TiO (refractive index n= 2.7) and on it as a high refractive-index material layer 2 which carries out a laminating on this b material 1. These ingredients are comparatively cheap, can be selected from the refractive-index difference of the hig refractive-index material 2 and the low refractive-index material 3 being comparatively large, and can also use other well-known ingredients.
[0025] thus -- if the laminating of the ingredient of a high refractive index and the ingredient of a low refractive inde is carried out on a glass flake with a smooth front face -- much more -- every -- since interference breaks out and it interferes also in the transmitted light, it can have a reflection factor to 90% or more easily, and can go. And if a reflection factor becomes 90% or more, it will come to be checked by looking with "a very vivid color." Drawing 8 i what showed this relation, and an axis of abscissa shows the depth of shade an axis of ordinate is judged to be by viewing in a reflection factor (%). When lack of hiding understands "the depth of shade 1" completely without sensin that the color was attached, a color senses that it was attached a little by "the depth of shade 2" and lack of hiding understands it well, Although "the depth of shade 4" senses "the depth of shade 3" that the color was attached considerably when it senses that the color was attached for a while and lack of hiding is known, and lack of hiding understands it a little, when a term does not come, "the depth of shade 5" senses that the color was attached complete and is the case where lack of hiding is not sensed. If a reflection factor becomes 90% or more, it will become more th "the depth of shade 4", and will come to be checked by looking with "a very vivid color."
[0026] The reason which such coloring produces can be explained as follows. For example, the light a reflected amo ** incident light by the interface between a base material 1 and the high refractive-index layer 2 of the right above of when a laminating is carried out to five layers, as shown in drawing 2 The light c reflected by the interface between interferential action with the light b reflected by the interface with the low refractive-index material layer 3 and the high refractive-index material layer 2, ** quantity refractive-index material layer 2, and the low refractive-index material layer 3 The light e reflected by the interface between interferential action with the light d reflected by the interface between the low refractive-index material layer 3 and the high refractive-index material layer 2, ** quantity refractive-index material layer 2, and the low refractive-index material layer 3 Interferential action with the light f reflected by the interface between air and the high refractive-index material layer 2 arises, a reflection factor become about 92%, and it will be in the condition of fulfilling the conditions of the 90 above-mentioned% or more.
[0027] On a substrate 1, a reflection factor R changes with number 2P+1 (however, P= 1, 2, --) of the membrane laye which carries out a laminating, and is expressed with a degree type here.
[0028]
[Equation 1]

$$R = \left[\frac{1 - (n_H / n_L)^{2P} (n_H^2 / n_g)}{1 + (n_H / n_L)^{2P} (n_H^2 / n_g)} \right]^2$$

n_H ；高屈折率材層の屈折率

n_L ；低屈折率材層の屈折率

n_g ；基材の屈折率

多層膜の層数 ；2P+1（但し、P＝1，2…）

Therefore, when the laminating of the reflection factor R is carried out to five layers on a substrate 1 and the laminat of the nine layers is carried out R = about 92%, it becomes R = about 99%.
[0029] The conventional titanium dioxide TiO2 incidentally Since there is light penetrated downward only in the cas of one layer, even if the amounts of the light which can be strengthened and taken out only in the layer concerned are few and it is high, it is only 43% only of reflection factors. This value is strength which is not sensed that the color is still attached enough, when human being sees. However, since it will come to sense as "a very vivid color" if a reflection factor R becomes 90% or more as mentioned above, the very thing can serve as effective coloring material only with these interference flakes 10, although the color is not attached.

[0030] Next, it divides into dry process and a wet method, and the manufacture approach of the coating containing th above-mentioned interference flake 10 and it is explained.
[0031] [Dry-process] drawing 3 shows the case where it is based on dry process.
[0032] ** first -- a thin glass plate -- titanium dioxide TiO2 Silica SiO2 quarter-wave length thickness -- alternation sputtering -- or it vapor-deposits. They are TiO2, SiO2, TiO2, SiO2, and TiO2 to a glass plate. It carries out in order. Thin glass is SiO2 to the quality of the material. It uses and considers as 10 micrometers of thickness. Sputtering or TiO2 to vapor-deposit SiO2 Thickness is as follows when blue with a wavelength of 480nm is the target hue.
TiO2 Thickness -- 1 / 4x480nm/2.7(refractive index) =44.4nmSiO2 Thickness -- 1/4x480nm/1.5(refractive index) =80.0nm[0033] ** Carry out refraction fracture of what was once vapor-deposited on glass thin as mentioned above with a roller. Although a ball mill etc. will usually grind, it is difficult to grind without then breaking a front face. Th with a bending fracture machine as shown in drawing 4 , it is based on a roller and refraction fracture is carried out. The wafer which was fractured and was obtained is shown in drawing 5 .
[0034] ** Next, sift out this fracture wafer 11 in required magnitude (about 20 micrometers or less), and take only a part for the interference flake of required magnitude.
[0035] ** Finally mix this interference flake into base coating resin. If it mixes into base coating resin, it will becom impossible to look white before mixing, since the interference flake is crushed, but to already distinguish, since the refractive index is almost the same as base coating resin. That is, if it applies as a coating afterwards, a white part wi disappear. Drawing 6 applies the coating 13 of the above-mentioned configuration on a base material 12, and shows paint scheme which formed the clear layer 14 further.
[0036] The manufacture approach by the wet method is shown in [wet method] drawing 7 . This makes a glass flake first.
[0037] ** Prepare C glass which is excellent in corrosion resistance as a raw material. The presentation of this C gla usually consists of SiO2 (65%), ZnO (4%), B-2 O3 (5%), and others.
[0038] ** Shaping, grinding, classification. Since thin glass must be made first, it is (1). The above-mentioned C gla is fused by about 1,000-degreeC, and it is (2). By making it the shape of a balloon and cooling with air, it operates orthopedically in fixed thickness. In addition, if it cools, it will be ground automatically (primary grinding). (3) A ba mill (steel) grinds still more finely this thing ground primarily. (4) Fly by the wind and classify the thing with a light thing heavy in the distance using falling to near.
[0039] ** Coat a titanium dioxide.
[0040] (1) Make water distribute a glass flake. (2) Add a titanium salt and tin<4> salt, hydrolyze and make a glass fl front face carry out the deposition of the titanium oxide hydrate to generate. Thickness is controlled by this time amount to attach. (3) Wash a product in cold water and make it dry. (4) Calcinate by C-1,000-degree C of 800 ", and consider as titanium oxide.
[0041] ** Coat a silica.
(1) Make water distribute a glass flake. (2) Add the tetra-ethoxy silane (OC two H5) Si 4, a hydrochloric acid HCl, a ethanol C2 H5 OH, make it hydrolyze and make a hydrate generate. Then, a polycondensation reaction occurs and it a silica SiO2 by the degree type. Deposition is carried out to a flake front face.
nSi(OC two H5)4+4nH2 O->nSi(OH)4+4nC2 H5 OHnSi(OH)4 ->nSiO2+2nH2 O(3) A product is washed in cold water and it is made to dry. (4) Heat by C-500-degree C of 400 ".
[0042] ** Coat a titanium dioxide like the above-mentioned step **.
[0043] ** Coat a silica like the above-mentioned step **.
[0044] ** Coat a titanium dioxide like the above-mentioned step **.
[0045] ** Finally, mix base coating resin and attain coating-ization which can be sprayed.
[0046] Although what mixed the pigment with the coating chemically-modified [of the above-mentioned dry proces and a wet method] degree as base coating resin of a substrate can also be used, it is desirable to use the color which absorbs light as base coating resin of a substrate, or the color of a same color system. It is because possibility of changing to other colors will become strong if the color of a different hue system too much from the color aimed at enters.
[0047] Although the titanium dioxide TiO2 (refractive index n= 2.7) was carried out as a high refractive-index mater layer 2 and the laminating of the silica SiO2 (refractive index n= 1.5) was carried out one by one as a low refractive-index material layer 3 in the above-mentioned example on the base material 1 which consists of a glass flake (refract index n= 1.5), other well-known ingredients can also be used.
[0048] As an inorganic substance, as other ingredients of interference coloring material, zinc sulfide ZnS (refractive index n= 2.37) is for example, in a low refractive-index material layer, and is in magnesium fluoride MgF2 (refractiv index n= 1.37) and a high refractive-index material layer, and R= 98.6% of reflection factors was able to be obtained nine layer membranes by sputtering.
[0049] Moreover, as interference coloring material of the organic substance, an acrylic copolymer (refractive index n

1.59) is in a low refractive-index material layer at a fluoro olefin-alkyl vinyl ether copolymer (refractive index n= 1.4 and a high refractive-index material layer, for example, and R= 90.5% of reflection factors was obtained in 49 layer membranes by the dipping method. A refractive-index difference can seldom come by the organic substance size so that it may understand from now on.

[0050] In addition, as an inorganic substance which can be used, SnO2 (refractive index n= 1.997) and ZnO (refracti index n=2.0-2.02) are in a low refractive-index material layer at aluminum 2O3 (refractive index n= 1.765) and a hig refractive-index material layer.

[0051] anyway -- if the laminating of the ingredient of a high refractive index and the ingredient of a low refractive index is carried out on a glass flake with a smooth front face as mentioned above -- much more -- every -- since interference breaks out and it interferes also in the transmitted light, it can have a reflection factor to 90% or more easily, and can go. And if a reflection factor becomes 90% or more, it will come to be checked by looking with "a ve vivid color."

[0052] By the way, although each of the high refractive-index material layer by which a laminating is carried out by turns, and a low refractive-index material layer was made into the abbreviation quarter-wave length of a setting interference light in the above-mentioned example, since this thickness is very thin, difficulty may actually be follow on the upper manufacture. For example, in the case of a wet method, the thickness once attached by coating exceeds quarter-wave length in many cases, and it is hard to double thickness.

[0053] Then, as shown in drawing 9 , each thickness d of the high refractive-index material layer 2 by which a laminating is carried out by turns, and the low refractive-index material layer 3 is made into odd times (odd times of optical thickness of the abbreviation quarter-wave length of setting interference coloring light) of the abbreviation quarter-wave length film which satisfies a degree type.

[0054]

d= [(2m+1) lambda] / 4n -- (2)

However, wavelength n of lambda:light: The refractive index m:0 of a refractive-index material layer, 1, 2, 3 -- Since becomes the loose conditions that the thickness d of each refractive-index material layer should just be odd times (od times of the optical thickness of the abbreviation quarter-wave length of setting interference coloring light) the 1-/(4n wavelength according to this, it becomes easy to double the thickness and there is an advantage that manufacture becomes easy. However, when referred to as m= 0, above all are attributed to the same result as the case where it considers as the abbreviation quarter-wave length film. In addition, although the refractive index shows the case of smallness, size, and smallness sequentially from the top by drawing 9 , the result is the same even if a refractive inde is the case of size, smallness, and smallness sequentially from a top.

[0055] Thus, although thickness of the high refractive-index material layer 2 by which a laminating is carried out by turns, and the low refractive-index material layer 3 is made into odd with a 1/4n wave [of the abbreviation for a setti interference light] (n: refractive index of a refractive-index material layer) times In this case, the laminating thicknes d just only satisfies the above-mentioned formula, and the thickness with all the high refractive-index material layers and same low refractive-index material all [one side or] 3, i.e., m, does not necessarily need to be the same (howeve it considers as m= integer).

[0056] For example, as shown in drawing 10 , when the laminating of the high refractive-index material layer 2 and low refractive-index material layer 3 is carried out by turns, it sets. those laminating thickness d -- the order from a to -- d1=lambda/(four n1) (m= 0) and d2=3lambda/(four n2) (m= 1) d3=7lambda/(four n1) (m= 3) d4=5lambda/(four n (m= 2) as -- it is changeable.

[0057] However, only one side of the high refractive-index material layer 2 by which a laminating is carried out by turns, and the low refractive-index material layer 3 may satisfy (2) types of the above-mentioned thickness d. In this case, on manufacture, although it is completely free about whether which of a high refractive-index material layer an low refractive-index material layer makes it agree on the conditions of odd times of 1-/(4n) wavelength, since it is easier to base adjustment of that thickness on dry process rather than a wet method and dry process generally treats t thing of high refractive-index material, it is good to adjust thickness by the high refractive-index material layer side. However, if it is dry process, since it will be easy to double thickness, you may make it double in the direction of a lo refractive-index material layer. Anyway, when a difference is in the ease of carrying out of thickness control of coati by wet or dry type, it becomes easy to double thickness by making the refractive-index material of the easier one of thickness control of the coating applicable to adjustment.

[0058] Above, although the case of the optical interference material as interference coloring material, i.e., the light, h been described, the above-mentioned optical interference material can also be constituted as a coating containing the heat ray reflector and it which reflect infrared radiation.

[0059] Since temperature in the car tends to rise that energy tends to be changed into heat by sunlight, the vehicle of black coating prevents the purpose of this heat ray reflector by mixing a transparent heat ray reflective flake for it.

[0060] The wavelength of the infrared radiation which is a heat ray is 770nm - 1mm, it is the thickness which satisfie

the above-mentioned (2) formula, carries out the laminating of the ingredient of a different refractive index to this lig to the base material which consists of transparent materials, such as glass and a mica, by turns, and obtains, the transparence flake, i.e., the optical interference material slack heat ray reflector, which gathered the reflection factor. The laminating of the ingredient in which a different refractive index to the wavelength of this infrared radiation is shown is good also as thickness which satisfies the above-mentioned (2) formula for each class, and good depending a situation also considering one side of a high refractive-index material layer and a low refractive-index material laye as one a wave (n: refractive index of a refractive-index material layer) of the 1/4n thickness [odd times thickness of this] of the abbreviation for a setting interference light. Anyway, even if visually visible to the coating of a dark colo system by making it mix into a paint film, such a transparence flake, i.e., an optical interference material slack heat r reflector, the coating which can be pressed down to the same temperature rise as a light color system can be obtained
[0061] Here, since infrared wavelength covered the heat ray wavelength whole region in consideration of continuing broadly, thickness (wavelength is determined) made two or more kinds of various interference flakes, and mixed and used them into the coating. That is, the object for the wavelength of 800-850nm, the object for 1000-1100nm, the object for 2000-2100nm, the object for 5000-5100nm, the object for 10000-10100nm, and a total of six sorts of heat reflector slack interference flakes 10 for wavelength for 20000 - 20100nm were produced. the base material 1 of the fine thin film integrated circuit which consists of glass as each interference flake 10 is shown in drawing 11 -- TiO_2 from -- the high refractive-index material layer 2 and SiO_2 which change from -- the nine-layer laminating of the low refractive-index material layer 3 which changes is carried out by turns, and the reflection factor is made into 90% or more. In the black coatings, 20w% addition was carried out, it mixed, six sorts of these heat ray reflector slack flakes were applied to the steel plate, sunlight was irradiated, and the temperature gradient was measured. Consequently, in the case of the usual black coating, in the case of the coating with which coating temperature carried out 20w% addition of the above-mentioned heat ray reflector slack flake to painted-surface temperature going up to 70-degreeC painted-surface temperature was suppressed by at least 58-degree C. That is, visually, even if visible to the coating o dark color system, it was able to hold down to the same temperature rise as a light color system.
[0062]
[Effect of the Invention] In short, according to this invention, the following outstanding effectiveness is acquired above.
1) According to the optical interference material of claims 1, 2, and 3, an easy configuration can raise a total beam-o light reflection factor effectively, and a deep interference light can be made to be able to color as a result, or a heat ra can be reflected. Moreover, since thickness is odd times the quarter-wave length, while skillful coloring with which a light other than the color aimed at is not mixed is obtained, a laminating can be carried out by the thickness which is easy to manufacture.
2) Especially, since a reflection factor is 90% or more in the optical interference material of claim 3, skillful coloring practical strength is obtained.
3) the color of the wavelength which according to claims 4, 5, and 6 the above-mentioned coloring material is mixed and has this -- enough -- a color -- since interference coloring is carried out deeply or heat ray reflection is carried ou the coating which discovers a desired vivid color without a pigment, and the coating which suppresses the temperatu rise by the heat ray can be obtained.
4) the optical interference material thru/or coating obtained by this invention -- the coating for vehicles (a passenger car, a motorcycle, and bicycle) -- beginning -- various coating and various plastics -- it scours and can be broadly use for the application of **, such as building materials, a wall covering material, printing ink, synthetic leather, sporting goods, furniture, paints, textile printing, lacquer ware, a carbon button, stationery, and an accessory.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to the coating containing the optical interference material and it which act as interference coloring material or a heat ray reflector.

[Translation done.]

* NOTICES *

PRIOR ART

[Description of the Prior Art] Recently, according to a demand of diversification of the design nature of a paint appearance, the metallic coating which includes the piece of aluminum (aluminum flake) and the pigment with comparatively high transparency of a fine thin film integrated circuit into a base coating, and the pearl mica paint wh includes the interference mica flake which coated the titanium dioxide (TiO_2), and a pigment with comparatively hig transparency in the mica (mica flake) of a fine thin film integrated circuit into a base coating have been used abundantly.
[0003] The interference mica flake included into a base coating in the latter pearl mica paint coats with the titanium-dioxide film 21 (refractive index n= 2.7) with a somewhat high refractive index the front face of the mica flake 20 (refractive-index n=1.5-2.0) which consists of the mica of a fine thin film integrated circuit by one fourth of the thickness (quadrant wavelength film) of the wavelength of the color of an aim, as shown in drawing 13 . As shown in drawing 14 , by interference with the reflected light 22 from the interface of a titanium oxide layer and a mica, and th reflected light 23 from the titanium oxide layer front face by which coating was carried out, only a certain wavelengt is made to emphasize, interference coloring is carried out, and it is observed as coloring material using interference o light.
[0004] About the mica base coating which blended the pigment currently used for current automobiles, JP,63-319087,A has indication, for example.
[0005] Moreover, the front face of a mica flake is made to cover a titanium dioxide to homogeneity, and JP,5-8342,A has the indication about the interference mica flake which re-covered the titanium dioxide on the front face, and obtained it on it again, and the sheet plastic which was made to distribute this in transparence resin and raised design nature, after returning this once and using some titanium dioxides as black low hypo---ic acid-ized titanium.
[0006] Since these interference mica flakes can make ********** Infinite Color of theory top infinity by adjusting t thickness of a black low hypo---ic acid-ized titanium and a black titanium dioxide, they attract attention as coloring material using interference of light.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] In short, according to this invention, the following outstanding effectiveness is acquired above.
1) According to the optical interference material of claims 1, 2, and 3, an easy configuration can raise a total beam-o light reflection factor effectively, and a deep interference light can be made to be able to color as a result, or a heat ra can be reflected. Moreover, since thickness is odd times the quarter-wave length, while skillful coloring with which a light other than the color aimed at is not mixed is obtained, a laminating can be carried out by the thickness which is easy to manufacture.
2) Especially, since a reflection factor is 90% or more in the optical interference material of claim 3, skillful coloring practical strength is obtained.
3) the color of the wavelength which according to claims 4, 5, and 6 the above-mentioned coloring material is mixed and has this -- enough -- a color -- since interference coloring is carried out deeply or heat ray reflection is carried ou the coating which discovers a desired vivid color without a pigment, and the coating which suppresses the temperatu rise by the heat ray can be obtained.
4) the optical interference material thru/or coating obtained by this invention -- the coating for vehicles (a passenger car, a motorcycle, and bicycle) -- beginning -- various coating and various plastics -- it scours and can be broadly use for the application of **, such as building materials, a wall covering material, printing ink, synthetic leather, sporting goods, furniture, paints, textile printing, lacquer ware, a carbon button, stationery, and an accessory.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, the conventional interference mica flake has a very thin color i itself [of the thing which can color various hues / coloring]. That is, since the titanium dioxide is the much more, a beam-of-light reflection factor becomes 43% or less, and it is hard to call that the color of appearance is thin and is coloring material.
[0008] Then, in order to compensate only with an interference mica flake single the fault that a color does not come out, the present condition is using it, mixing a pigment with others in fact. For this reason, it had also become light other than the color aimed at being mixed, and not looking skillfully.
[0009] The purpose of this invention is to offer the coating containing the optical interference material and it which t above-mentioned technical problem is solved, and coloring can be skillfully done in the strength which deserves call coloring material only alone, without using a pigment, or can reflect a heat ray.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the optical interference material of this invention is the thing of a configuration of having carried out the laminating of a high refractive-index material layer and the low refractive-index material layer to the base material respectively by turns by odd times as much opti thickness (geometric thickness x refractive index) as the abbreviation quarter-wave length of a setting interference li (claim 1).
[0011] That refractive index makes the above-mentioned base material what has opposite height with the refractive index of the refractive-index material layer by which a laminating is carried out to right above [of this] (claim 2).
[0012] Moreover, in these optical interference material, a desirable total reflection factor considers as 90% or more o interference coloring material (claim 3).
[0013] On the other hand, the coating of this invention is the thing of a configuration of having mixed optical interference material according to claim 1, i.e., the thing which carried out the laminating of a high refractive-index material layer and the low refractive-index material layer respectively by turns at the base material by odd times as much optical thickness as the abbreviation quarter-wave length of a setting interference light, into base coating resin (claim 4).
[0014] Optical interference material according to claim 2 or optical interference material according to claim 3 can be mixed into base coating resin, and it can also consider as a coating (claims 5 and 6).

[Translation done.]

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OPERATION

[Function] As shown in drawing 12 , a high refractive-index material layer (refractive index n1) and a low refractive index material layer (refractive index n2) by turns When the laminating is carried out by dense, the non-dense, dense and the non-dense, although the phase of light does not change about the light a and c reflected when light goes to secret non-denses, about the light b reflected when going densely from a non-dense, the phase of light carries out hal wave length change. Then, if these phases are arranged, the light of a and b will interfere, for example. Here, it is a refractive index n2 for considering the phase shift of the light of a and b. When thickness of a low refractive-index material layer is set to x, about the optical distance of b, they are 2 x-n2. Since the phase is carrying out half-wave length change when Light b is reflected, although it becomes, it is -(2x+(one half) lambda) n2 in fact. It becomes. On the other hand, since, as for the optical part of a, the phase is not changing, the light of b is -(2x+(one half) lambda) n =mlambda. (m= 1, 2, 3 --)
It suits in a slight light and the slight strength of a at the time of **. When this is solved about x, it is x=(2m-1) lamb (four n2). (m= 1, 2, 3 --)
The low refractive-index material layer (refractive index n2) of light [a next door and] of b suits in slight Light a an slight strength at the time of one odd times the thickness of lambda/(4n2).
[0016] This invention applies such a principle.
[0017] A setting interference light is the light and claim 1 includes two gestalten, the case where optical interference material is obtained as interference coloring material, and when a setting interference light is a heat ray (infrared radiation) and it is obtained as a heat ray reflector.
[0018] It sets at claims 1, 2, and 3 to explain from the gestalt as interference coloring material. For example, the ligh which is reflected among ** incident light by the interface between a base material 1 and the high refractive-index layer 2 of the right above of it in the case of five layers shown in drawing 2 The light c reflected by interferential act with the light b reflected by the interface with the low refractive-index material layer 3 and the high refractive-index material layer 2, and the interface between ** quantity refractive-index material layer 2 and the low refractive-index material layer 3 Interferential action with the light f reflected by the interface between Light e and air which are reflected by interferential action with the light d reflected by the interface between the low refractive-index material layer 3 and the high refractive-index material layer 2 and the interface between ** quantity refractive-index material layer 2 and the low refractive-index material layer 3, and the high refractive-index material layer 2 arises.
[0019] namely, the conventional titanium dioxide -- although the color of appearance was very thin since the beam-o light reflection factor had become 43% or less when the much more -- the above-mentioned laminated structure -- a total beam-of-light reflection factor -- an easy configuration -- effective -- it can raise -- a result -- a deep interferenc light -- it can color . Moreover, since the thickness of a titanium dioxide is odd times the quarter-wave length, skillfu coloring with which any light other than the color aimed at is not mixed is obtained.
[0020] Since a reflection factor is especially 90% or more in claim 3, remarkable effectiveness is acquired.
[0021] The coating of claims 4, 5, and 6 makes the above coloring material mix. although it is transparent in itself [optical interference material] -- the laminating of refractive-index material -- the color of a certain wavelength -- enough -- a color -- since it is what can carry out interference coloring deeply, a desired coating can be obtained without a pigment.
[0022] The gestalt as a heat ray reflector is made into the heat ray reflector in which infrared radiation is reflected by the above-mentioned principle, and the heating value which the base of an automobile itself absorbs is decreased, it i suitable for the application of suppressing the temperature rise of an automobile, and it is constituted as a coating corresponding to above-mentioned claims 4-6 containing the heat ray reflector and it corresponding to the optical interference material of above-mentioned claims 1-3 therefore.

[Translation done.]

EXAMPLE

[Example] Hereafter, one example of this invention is explained in full detail based on an accompanying drawing. Drawing 1 carries out the laminating of the high refractive-index material layer 2 and the low refractive-index mater layer 3 to the base material 1 of a fine thin film integrated circuit respectively by turns by the optical thickness (geometric thickness x refractive index) of the abbreviation quarter-wave length of setting interference coloring light and makes a reflection factor 90% or more so that drawing 2 which showed the cross section of the interference coloring material slack interference flake 10 of this invention, and expanded and showed the A section may show.
[0024] Here, the glass flake (refractive index n= 1.5) is used as a base material 1 of a fine thin film integrated circuit it is an ingredient used as the base, although this base material 1 is good, since it is desirable to actually make this smooth and to arrange a curve, the glass flake is being used for it anything here. Moreover, the silica $SiO2$ (refractiv index n= 1.5) is used as a low refractive-index material layer 3 which carries out a laminating a titanium dioxide TiO (refractive index n= 2.7) and on it as a high refractive-index material layer 2 which carries out a laminating on this b material 1. These ingredients are comparatively cheap, can be selected from the refractive-index difference of the hig refractive-index material 2 and the low refractive-index material 3 being comparatively large, and can also use other well-known ingredients.
[0025] thus -- if the laminating of the ingredient of a high refractive index and the ingredient of a low refractive inde is carried out on a glass flake with a smooth front face -- much more -- every -- since interference breaks out and it interferes also in the transmitted light, it can have a reflection factor to 90% or more easily, and can go. And if a reflection factor becomes 90% or more, it will come to be checked by looking with "a very vivid color." Drawing 8 i what showed this relation, and an axis of abscissa shows the depth of shade an axis of ordinate is judged to be by viewing in a reflection factor (%). When lack of hiding understands "the depth of shade 1" completely without sensin that the color was attached, a color senses that it was attached a little by "the depth of shade 2" and lack of hiding understands it well, Although "the depth of shade 4" senses "the depth of shade 3" that the color was attached considerably when it senses that the color was attached for a while and lack of hiding is known, and lack of hiding understands it a little, when a term does not come, "the depth of shade 5" senses that the color was attached complete and is the case where lack of hiding is not sensed. If a reflection factor becomes 90% or more, it will become more th "the depth of shade 4", and will come to be checked by looking with "a very vivid color."
[0026] The reason which such coloring produces can be explained as follows. For example, the light a reflected amo ** incident light by the interface between a base material 1 and the high refractive-index layer 2 of the right above of when a laminating is carried out to five layers, as shown in drawing 2 The light c reflected by the interface between interferential action with the light b reflected by the interface with the low refractive-index material layer 3 and the high refractive-index material layer 2, ** quantity refractive-index material layer 2, and the low refractive-index material layer 3 The light e reflected by the interface between interferential action with the light d reflected by the interface between the low refractive-index material layer 3 and the high refractive-index material layer 2, ** quantity refractive-index material layer 2, and the low refractive-index material layer 3 Interferential action with the light f reflected by the interface between air and the high refractive-index material layer 2 arises, a reflection factor become about 92%, and it will be in the condition of fulfilling the conditions of the 90 above-mentioned% or more.
[0027] On a substrate 1, a reflection factor R changes with number 2P+1 (however, P= 1, 2, --) of the membrane laye which carries out a laminating, and is expressed with a degree type here.
[0028]
[Equation 1]

$$R = \left[\frac{1 - (n_H / n_L)^{2P} (n_H^2 / n_g)}{1 + (n_H / n_L)^{2P} (n_H^2 / n_g)} \right]^2$$

n_H ；高屈折率材層の屈折率

n_L ；低屈折率材層の屈折率

n_g ；基材の屈折率

多層膜の層数 ； 2P+1（但し、P＝1，2…）

Therefore, when the laminating of the reflection factor R is carried out to five layers on a substrate 1 and the laminat of the nine layers is carried out R = about 92%, it becomes R = about 99%.
[0029] The conventional titanium dioxide TiO2 incidentally Since there is light penetrated downward only in the cas of one layer, even if the amounts of the light which can be strengthened and taken out only in the layer concerned are few and it is high, it is only 43% only of reflection factors. This value is strength which is not sensed that the color is still attached enough, when human being sees. However, since it will come to sense as "a very vivid color" if a reflection factor R becomes 90% or more as mentioned above, the very thing can serve as effective coloring material only with these interference flakes 10, although the color is not attached.
[0030] Next, it divides into dry process and a wet method, and the manufacture approach of the coating containing th above-mentioned interference flake 10 and it is explained.
[0031] [Dry-process] drawing 3 shows the case where it is based on dry process.
[0032] ** first -- a thin glass plate -- titanium dioxide TiO2 Silica SiO2 quarter-wave length thickness -- alternation sputtering -- or it vapor-deposits. They are TiO2, SiO2, TiO2, SiO2, and TiO2 to a glass plate. It carries out in order. Thin glass is SiO2 to the quality of the material. It uses and considers as 10 micrometers of thickness. Sputtering or TiO2 to vapor-deposit SiO2 Thickness is as follows when blue with a wavelength of 480nm is the target hue.
TiO2 Thickness -- 1 / 4x480nm/2.7(refractive index) =44.4nmSiO2 Thickness -- 1/4x480nm/1.5(refractive index) =80.0nm[0033] ** Carry out refraction fracture of what was once vapor-deposited on glass thin as mentioned above with a roller. Although a ball mill etc. will usually grind, it is difficult to grind without then breaking a front face. Th with a bending fracture machine as shown in drawing 4 , it is based on a roller and refraction fracture is carried out. The wafer which was fractured and was obtained is shown in drawing 5 .
[0034] ** Next, sift out this fracture wafer 11 in required magnitude (about 20 micrometers or less), and take only a part for the interference flake of required magnitude.
[0035] ** Finally mix this interference flake into base coating resin. If it mixes into base coating resin, it will becom impossible to look white before mixing, since the interference flake is crushed, but to already distinguish, since the refractive index is almost the same as base coating resin. That is, if it applies as a coating afterwards, a white part wi disappear. Drawing 6 applies the coating 13 of the above-mentioned configuration on a base material 12, and shows paint scheme which formed the clear layer 14 further.
[0036] The manufacture approach by the wet method is shown in [wet method] drawing 7 . This makes a glass flake first.
[0037] ** Prepare C glass which is excellent in corrosion resistance as a raw material. The presentation of this C gla usually consists of SiO2 (65%), ZnO (4%), B-2 O3 (5%), and others.
[0038] ** Shaping, grinding, classification. Since thin glass must be made first, it is (1). The above-mentioned C gla is fused by about 1,000-degreeC, and it is (2). By making it the shape of a balloon and cooling with air, it operates orthopedically in fixed thickness. In addition, if it cools, it will be ground automatically (primary grinding). (3) A ba mill (steel) grinds still more finely this thing ground primarily. (4) Fly by the wind and classify the thing with a light thing heavy in the distance using falling to near.
[0039] ** Coat a titanium dioxide.
[0040] (1) Make water distribute a glass flake. (2) Add a titanium salt and tin<4> salt, hydrolyze and make a glass fl front face carry out the deposition of the titanium oxide hydrate to generate. Thickness is controlled by this time amount to attach. (3) Wash a product in cold water and make it dry. (4) Calcinate by C-1,000-degree C of 800 ", and consider as titanium oxide.
[0041] ** Coat a silica.
(1) Make water distribute a glass flake. (2) Add the tetra-ethoxy silane (OC two H5) Si 4, a hydrochloric acid HCl, a ethanol C2 H5 OH, make it hydrolyze and make a hydrate generate. Then, a polycondensation reaction occurs and it a silica SiO2 by the degree type. Deposition is carried out to a flake front face.
nSi(OC two H5)4+4nH2 O->nSi(OH)4+4nC2 H5 OHnSi(OH)4 ->nSiO2+2nH2 O(3) A product is washed in cold

water and it is made to dry. (4) Heat by C-500-degree C of 400 ".
[0042] ** Coat a titanium dioxide like the above-mentioned step **.
[0043] ** Coat a silica like the above-mentioned step **.
[0044] ** Coat a titanium dioxide like the above-mentioned step **.
[0045] ** Finally, mix base coating resin and attain coating-ization which can be sprayed.
[0046] Although what mixed the pigment with the coating chemically-modified [of the above-mentioned dry proces and a wet method] degree as base coating resin of a substrate can also be used, it is desirable to use the color which absorbs light as base coating resin of a substrate, or the color of a same color system. It is because possibility of changing to other colors will become strong if the color of a different hue system too much from the color aimed at enters.
[0047] Although the titanium dioxide TiO_2 (refractive index n= 2.7) was carried out as a high refractive-index mater layer 2 and the laminating of the silica SiO_2 (refractive index n= 1.5) was carried out one by one as a low refractive-index material layer 3 in the above-mentioned example on the base material 1 which consists of a glass flake (refract index n= 1.5), other well-known ingredients can also be used.
[0048] As an inorganic substance, as other ingredients of interference coloring material, zinc sulfide ZnS (refractive index n= 2.37) is for example, in a low refractive-index material layer, and is in magnesium fluoride MgF_2 (refractiv index n= 1.37) and a high refractive-index material layer, and R= 98.6% of reflection factors was able to be obtained nine layer membranes by sputtering.
[0049] Moreover, as interference coloring material of the organic substance, an acrylic copolymer (refractive index n 1.59) is in a low refractive-index material layer at a fluoro olefin-alkyl vinyl ether copolymer (refractive index n= 1.4 and a high refractive-index material layer, for example, and R= 90.5% of reflection factors was obtained in 49 layer membranes by the dipping method. A refractive-index difference can seldom come by the organic substance size so that it may understand from now on.
[0050] In addition, as an inorganic substance which can be used, SnO_2 (refractive index n= 1.997) and ZnO (refracti index n=2.0-2.02) are in a low refractive-index material layer at aluminum 2O3 (refractive index n= 1.765) and a hig refractive-index material layer.
[0051] anyway -- if the laminating of the ingredient of a high refractive index and the ingredient of a low refractive index is carried out on a glass flake with a smooth front face as mentioned above -- much more -- every -- since interference breaks out and it interferes also in the transmitted light, it can have a reflection factor to 90% or more easily, and can go. And if a reflection factor becomes 90% or more, it will come to be checked by looking with "a ve vivid color."
[0052] By the way, although each of the high refractive-index material layer by which a laminating is carried out by turns, and a low refractive-index material layer was made into the abbreviation quarter-wave length of a setting interference light in the above-mentioned example, since this thickness is very thin, difficulty may actually be follow on the upper manufacture. For example, in the case of a wet method, the thickness once attached by coating exceeds quarter-wave length in many cases, and it is hard to double thickness.
[0053] Then, as shown in drawing 9 , each thickness d of the high refractive-index material layer 2 by which a laminating is carried out by turns, and the low refractive-index material layer 3 is made into odd times (odd times of optical thickness of the abbreviation quarter-wave length of setting interference coloring light) of the abbreviation quarter-wave length film which satisfies a degree type.
[0054]
d= [(2m+1) lambda] / 4n -- (2)
However, wavelength n of lambda:light: The refractive index m:0 of a refractive-index material layer, 1, 2, 3 -- Since becomes the loose conditions that the thickness d of each refractive-index material layer should just be odd times (od times of the optical thickness of the abbreviation quarter-wave length of setting interference coloring light) the 1-/(4n wavelength according to this, it becomes easy to double the thickness and there is an advantage that manufacture becomes easy. However, when referred to as m= 0, above all are attributed to the same result as the case where it considers as the abbreviation quarter-wave length film. In addition, although the refractive index shows the case of smallness, size, and smallness sequentially from the top by drawing 9 , the result is the same even if a refractive inde is the case of size, smallness, and smallness sequentially from a top.
[0055] Thus, although thickness of the high refractive-index material layer 2 by which a laminating is carried out by turns, and the low refractive-index material layer 3 is made into odd with a 1/4n wave [of the abbreviation for a setti interference light] (n: refractive index of a refractive-index material layer) times In this case, the laminating thicknes d just only satisfies the above-mentioned formula, and the thickness with all the high refractive-index material layers and same low refractive-index material all [one side or] 3, i.e., m, does not necessarily need to be the same (howeve it considers as m= integer).
[0056] For example, as shown in drawing 10 , when the laminating of the high refractive-index material layer 2 and

low refractive-index material layer 3 is carried out by turns, it sets. those laminating thickness d -- the order from a to -- d1=lambda/(four n1) (m= 0) and d2=3lambda/(four n2) (m= 1) d3=7lambda/(four n1) (m= 3) d4=5lambda/(four n (m= 2) as -- it is changeable.

[0057] However, only one side of the high refractive-index material layer 2 by which a laminating is carried out by turns, and the low refractive-index material layer 3 may satisfy (2) types of the above-mentioned thickness d. In this case, on manufacture, although it is completely free about whether which of a high refractive-index material layer an low refractive-index material layer makes it agree on the conditions of odd times of 1-/(4n) wavelength, since it is easier to base adjustment of that thickness on dry process rather than a wet method and dry process generally treats t thing of high refractive-index material, it is good to adjust thickness by the high refractive-index material layer side. However, if it is dry process, since it will be easy to double thickness, you may make it double in the direction of a lo refractive-index material layer. Anyway, when a difference is in the ease of carrying out of thickness control of coati by wet or dry type, it becomes easy to double thickness by making the refractive-index material of the easier one of thickness control of the coating applicable to adjustment.

[0058] Above, although the case of the optical interference material as interference coloring material, i.e., the light, h been described, the above-mentioned optical interference material can also be constituted as a coating containing the heat ray reflector and it which reflect infrared radiation.

[0059] Since temperature in the car tends to rise that energy tends to be changed into heat by sunlight, the vehicle of black coating prevents the purpose of this heat ray reflector by mixing a transparent heat ray reflective flake for it.

[0060] The wavelength of the infrared radiation which is a heat ray is 770nm - 1mm, it is the thickness which satisfie the above-mentioned (2) formula, carries out the laminating of the ingredient of a different refractive index to this lig to the base material which consists of transparent materials, such as glass and a mica, by turns, and obtains, the transparence flake, i.e., the optical interference material slack heat ray reflector, which gathered the reflection factor. The laminating of the ingredient in which a different refractive index to the wavelength of this infrared radiation is shown is good also as thickness which satisfies the above-mentioned (2) formula for each class, and good depending a situation also considering one side of a high refractive-index material layer and a low refractive-index material laye as one a wave (n: refractive index of a refractive-index material layer) of the 1/4n thickness [odd times thickness of this] of the abbreviation for a setting interference light. Anyway, even if visually visible to the coating of a dark colo system by making it mix into a paint film, such a transparence flake, i.e., an optical interference material slack heat r reflector, the coating which can be pressed down to the same temperature rise as a light color system can be obtained

[0061] Here, since infrared wavelength covered the heat ray wavelength whole region in consideration of continuing broadly, thickness (wavelength is determined) made two or more kinds of various interference flakes, and mixed and used them into the coating. That is, the object for the wavelength of 800-850nm, the object for 1000-1100nm, the object for 2000-2100nm, the object for 5000-5100nm, the object for 10000-10100nm, and a total of six sorts of heat reflector slack interference flakes 10 for wavelength for 20000 - 20100nm were produced. the base material 1 of the fine thin film integrated circuit which consists of glass as each interference flake 10 is shown in drawing 11 -- TiO_2 from -- the high refractive-index material layer 2 and SiO_2 which change from -- the nine-layer laminating of the low refractive-index material layer 3 which changes is carried out by turns, and the reflection factor is made into 90% or more. In the black coatings, 20w% addition was carried out, it mixed, six sorts of these heat ray reflector slack flakes were applied to the steel plate, sunlight was irradiated, and the temperature gradient was measured. Consequently, in the case of the usual black coating, in the case of the coating with which coating temperature carried out 20w% addition of the above-mentioned heat ray reflector slack flake to painted-surface temperature going up to 70-degreeC painted-surface temperature was suppressed by at least 58-degree C. That is, visually, even if visible to the coating o dark color system, it was able to hold down to the same temperature rise as a light color system.

[Translation done.]

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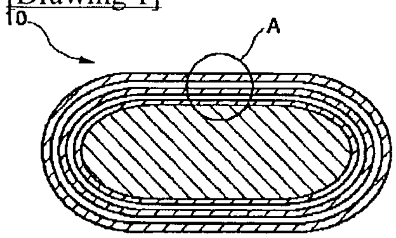
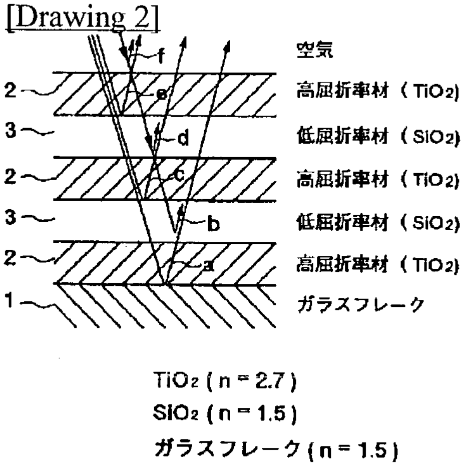
DRAWINGS

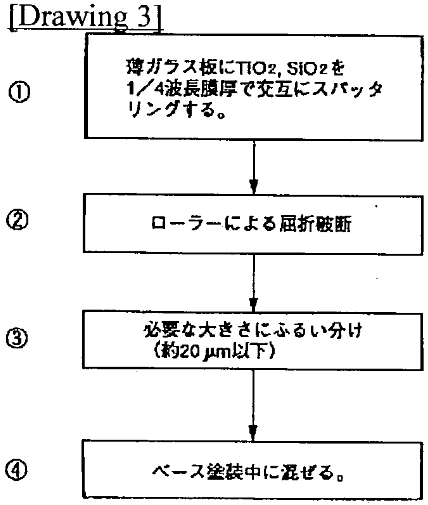
[Drawing 1]



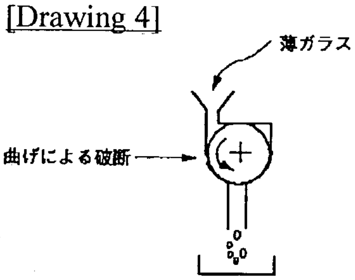
[Drawing 2]



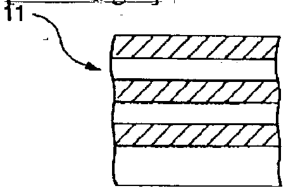
[Drawing 3]



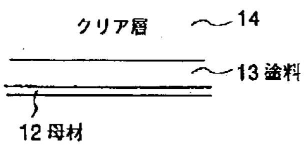
[Drawing 4]



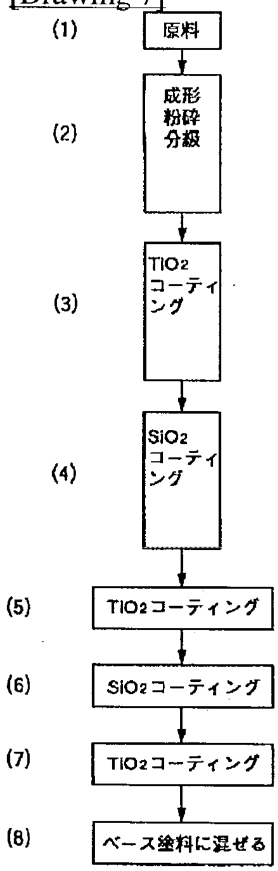
[Drawing 5]



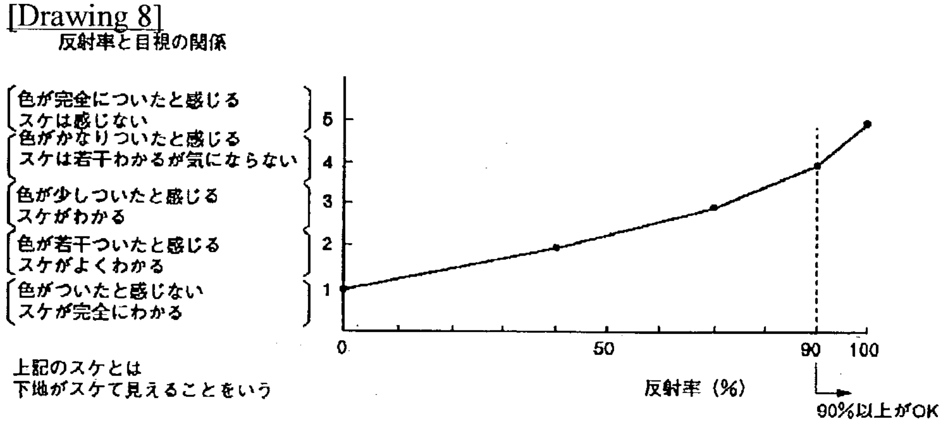
[Drawing 6]



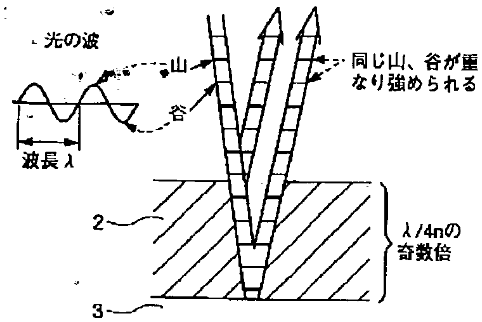
[Drawing 7]



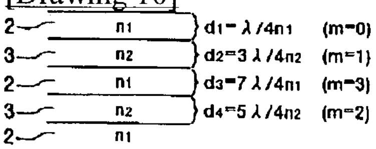
[Drawing 8]



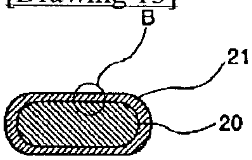
[Drawing 9]



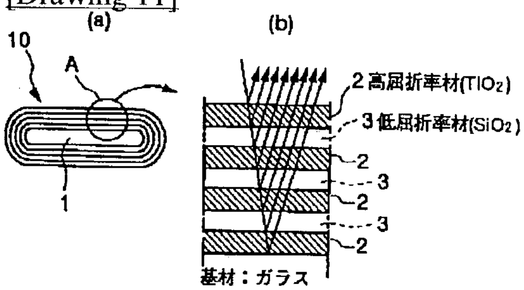
[Drawing 10]



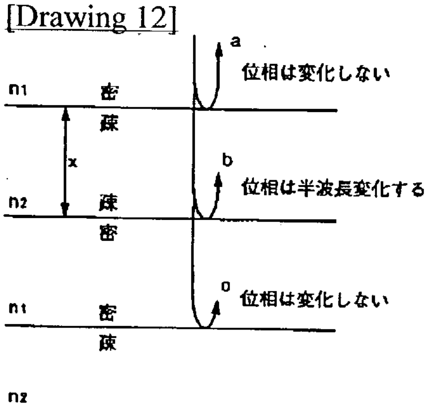
[Drawing 13]



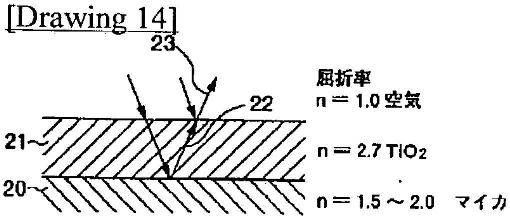
[Drawing 11]



[Drawing 12]



[Drawing 14]



[Translation done.]